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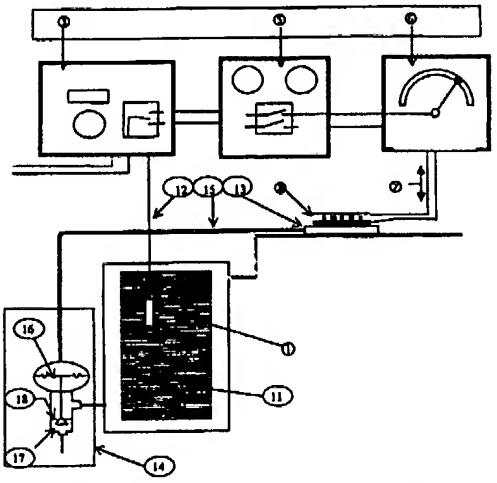
For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: A NOVEL ELECTRO-THERMAL CONTROL DEVICE



(57) Abstract: The invention relates to a novel electro-thermal control device for producing mechanical motion using only electricity. The device comprises of a sensor (1) for measuring the variable, which sends signals via sensor line (2) to the controller (3). The controller (3) has one or more set points operating as Relay (4). The output by Relay is sent to the variable D.C. Power supply (6) through Cyclic Timer (5) by adjusting output current (7). The output current is variable due to polarity from Cyclic Timer (5). The output current (7) is passed further through peltier chips (8), either side of same is in contact with Fluid filled bulb (13) attached to the expansion valve (14) through capillary tube (15). The peltier chips further heat or cool the fluid in fluid filled bulb (13) wherein it expands, contracts, condenses or evaporates thus the pressure on the diaphragm (16) in expansion valve (14) moves the Refrigerant Metering Needle (17) in or out of valve orifice (18) controlling the flow of refrigerant and achieving cooling effect by entering into cooling coil (11).

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Title : **A NOVEL ELECTRO-THERMAL CONTROL DEVICE**

This invention relates to an electro thermal control device for producing mechanical motion using only electricity, but without using Electro-magnetic devices such as solenoids or electric motors and specifically to the use of such motion for precise execution of various control functions involving various process parameters such as temperature, flow etc.

Traditionally, the power elements in a control loop, also known as operators or actuators, use hydraulic, pneumatic or electrical power to translate a control signal into linear or circular motion, which would then operate a lever or modulate a valve. The first two means require a compressor or hydraulic power unit to produce a high pressure fluid, which is then metered into a cylinder, bellows or diaphragm of the operator to produce the required motion. This equipment is complex, bulky, slow and inefficient. The direct electric operation requires electromagnetic devices such as motors, solenoids or magnets which have the same drawbacks. In some control loops, pneumatic or hydraulic systems operate in tandem with electric elements, thus compounding the complexity.

The object of the invention is to devise a simple, lightweight, novel means and method of quickly producing powerful linear, circular or curvilinear motion, caused and controlled both in forward and reverse directions only by electricity, without using any solenoids, magnets, magnetic fields, motors, resistance elements, copper coils or iron cores.

It is also the object of the invention to have a device which is very simple in construction, easy for operation and also available at an affordable price.

To understand the principle, let us examine a gas filled thermometer. With a rise in temperature, the pressure of gas in the sensor bulb rises, causing a bourdon tube

to move a pointer on the dial. This effect is enhanced if, instead of gas, the bulb is evacuated and then partially filled with a volatile liquid whose vapour will then fill the empty space. Liquid and vapour will establish an equilibrium, which will change as the bulb temperature rises or falls. As liquid converts into vapour and vice versa, the large change in the volume between the two states causes a greater variation in pressure than a bulb filled with a pure gas for an equal change in temperature. Thus a stronger thrust is applied to the bourdon tube causing greater movement of the pointer and making the instrument more sensitive than the gas filled unit. The same basic system is used for metering fluid flow or to throw a switch. A diaphragm or bellows can be used in place of the bourdon tube and, with an appropriate linkage, the desired motion would be produced to operate dials, switches, levers or metering devices within a control loop.

However, as is the case in all on/off - proportional control systems, there is a lag between the sensor and the output due to inertia of its components as well as the clearances within the component train. There is no response to any change of the sensor signal within this dead band of say 10 to 15% of full scale. This is unacceptable in many cases. The current solution is a Prortional Integral Differential (PID) Control which is quite complicated and expensive.

Disclosure of Invention :

The method so invented is a simple, lightweight, novel means and method of quickly producing a powerful linear, circular or curvilinear motion, caused and controlled both in forward and reverse directions only by electricity, without using any solenoids, magnets, magnetic fields, motors, resistance elements, copper coils or iron cores.

It employs the peltier effect to heat or cool, by direct contact, a low volume insulated chamber, having low thermal mass, partially filled with only a volatile

liquid in equilibrium with its own vapour, causing the evaporation of the liquid or condensation of the vapour, depending directly on the positive or negative flow of electric current through the peltier device, resulting in raising or lowering of the pressure within the chamber which acts on a diaphragm or bellows to produce forward or reverse motion whose speed and force are precisely controlled, within a predetermined range, by varying only the current polarity of the electrical energy fed into the peltier device. In another variation a non-volatile fluid is used to produce the same action by a simple expansion or contraction.

In another embodiment, the peltier device is kept in close direct thermal contact with a piece of shape memory metal (an alloy of nickel & tin) formed such that it has two stable shapes, like say straight or bent, at two different temperatures. As the peltier chip is heated or cooled quickly by switching polarity of the electric current, the metal will snap between the two states, thus operating a switch, or moving a lever to produce motion. In another variation, a rod of copper, a bimetal strip or disc, or any other material having a high coefficient of thermal expansion can also be used with the peltier device instead of shape memory alloy.

The distinctive novelty is that the peltier device can heat or cool quickly depending upon the polarity and the current. As used in the above invention, it amplifies the effect of a small change in the measured variable and applies a strong corrective force to the controlling device. It is like adding power steering to a car.

This system is superior to the current practice where the expansion valve has to wait till it can sense the change in the refrigerant gas temperature caused by the change in the air temperature and does not respond to it directly.

Brief Description of Drawings :

Now the invention will be more clearly described with reference to Figures 1, 2 and 3

of accompanying drawings wherein figure 1shows basic design, figure 2 shows precision Refrigeration Control and figure 3 shows a Magnetless electro-mechanical switch.

Referring to **Figure 1**,

An electro-thermal control device which comprises a **Sensor** (1) which measure the variable to be controlled and sends the signal via the **Sensor Line** (2) to the **Controller** (3) having one or more variable set points, each operating a **Relay** (4), the relay output is further sent through a **Cyclic Timer** (5) to the **Variable D.C. Power Supply** (6), the **Output Current** (7) generated is raised, lowered or changed in polarity in response to the signal form the **Cyclic Timer** (5) from the **Controller** (3), the **Output Current** (7) of which further passes through one or more **Peltier Chips** (8) which are attached to the **Thermo-Hydraulic or a Thermo-Mechanical Operator** (9), the **Peltier Chips** (8) will heat or cool the **Thermo Hydraulic or a Thermo Mechanical Operator** (9) in the precise proportion to the value and the direction of the **Output Current** (7), thereby then produces the mechanical motion of the **Arm/Rod** (10) with a considerable force generated by thermal expansion of the fluid in the **Thermo-Hydraulic or a Thermo-Mechanical Operator** (9) or change of shape of the **Stripe of the Shape Memory Alloy [Figure 3 (19)]**, this is more explained in the **Figure 3**. The **Cyclic Timer** (5) inactivates the control device for a set interval so as to prevent over control and hunting. In addition, a multiplicity of control devices, interconnecting pipes & wires and accessories, covers, appurtenances & miscellaneous equipment designed such that the device is energy efficient and stable, besides being lightweight and compact, through its unique and innovative design.

More specifically it relates to control of an refrigeration/air conditioning plant for maintaining precise space temperature and saving energy which is now described in detail.

Operation :

Referring to **Figure 2**

An electro-thermal control device which comprises a **Sensor** (1) measures the temperature of the air going into the **Cooling Coil** (11) and sends it to the **Temperature Controller** (3) via the **Sensor Line** (12). The **Temperature Controller** (3) then compares it to the set point. The **Variable D.C. Power Supply** (6) then adjusts the **Output Current** (7) being supplied to the **Peltier Chips** (8) causing a change in its surface temperature. The cold side of the **Peltier Chips** (8) is in contact with the **Fluid Filled Bulb** (8) attached to the **Expansion Valve** (14) by the **Capillary Tube** (15). The **Peltier Chip** (8) changes the temperature of the fluid in the **Fluid Filled Bulb** (13) and causes the fluid to either evaporate or condense, thereby changing the pressure of the fluid acting on the **Diaphragm** (16) of the **Expansion Valve** (14) which moves the **Refrigerant Metering Needle** (17) in or out of the **Valve Orifice** (18). Thus the flow of the refrigerant, and therefore the cooling effect, is directly and precisely controlled by the temperature of the air going into the **Cooling Coil** (11). The **Cyclic Timer** (5) inactivates the control device for a set interval so as to prevent overcontrol and hunting.

Referring to **Figure 3**

which is a Magnetless Electro-Mechanical Switch wherein, a **Stripe of the Shape Memory Alloy** (19) changes its shape and snaps up or down depending on whether the **Pltier Chips** (8) is heating or cooling. This is controlled by switching the direction of the current flow through the **Peltier Chips** (8).

CLAIM

1. An Electro-Thermal control device which comprise of a **Sensor** (1) for measuring the variable to be controlled, which sends the signal via **Sensor Line** (2) to the **Controller** (3), which measures the temperature of air which has one or more set points each operating a **Relay** (4), the Relay Output is further sent through a **Cyclic Timer** (5) to the **Variable D C Power Supply** (6), which adjusts **Output Current** (7) thus the current is raised, lowered or change in polarity in response to the signal from **Cyclic Timer** (5) of the **Controller** (3), the **Output Current** (7) of which further passes through **Peltier Chips** (8) wherein one side of the **Peltier Chips** (8) in contact with the **Fluid Filled Bulb** (13) attached to the **Expansion Valve** (14) through **Capillary Tube** (15), whereby the **Peltier Chips** (8) further heat or cool the fluid in the **Fluid Filled Bulb** (13) wherein the fluid expands, contracts, condenses or evaporates thus the pressure on the **Diaphragm** (16) in **Expansion Valve** (14) moves the **Refrigerant Metering Needle** (17) in or out of the **Valve Orifice** (18) controlling the flow of refrigerant and cooling effect by the temperature of air entering into the **Cooling Coil** (11), or in another version the fluid in a **Fluid Filled Bulb** (13) operates a **Thermal Mechanical Operator** (9) in precise proportion and the direction of the **Output Current** (7) thereby produces a mechanical motion of the **Arm/Rod** (10) with a force exerted by the thermal expansion of the fluid.

2. A Peltier Device as claimed in Claim No. 1, is kept in close and direct thermal contact with a piece of **Shape Memory Metal** (19) (an alloy of nickel & tin) formed such that it has two stable shapes, like say straight or bent, at two different temperatures because the **Peltier Chip** (8) is heated or cooled, the metal will snap between the two states, thus operating a switch, or moving a lever to produce motion while in yet another variation, a rod of

copper, a bimetal strip or disc, or any other material having a high coefficient of thermal expansion is used instead of the shape memory metal.

3. An Electro-Thermal Control Device as described under Claim No. 1, 2 and 3 above and as referred in the accompanying drawings.

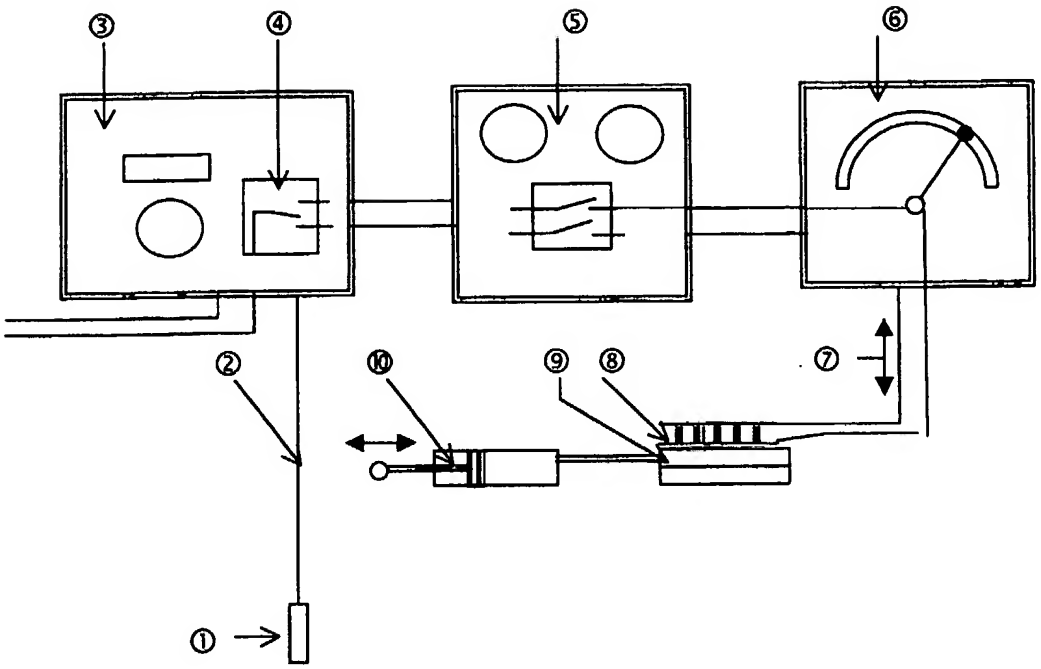

FIGURE - 1

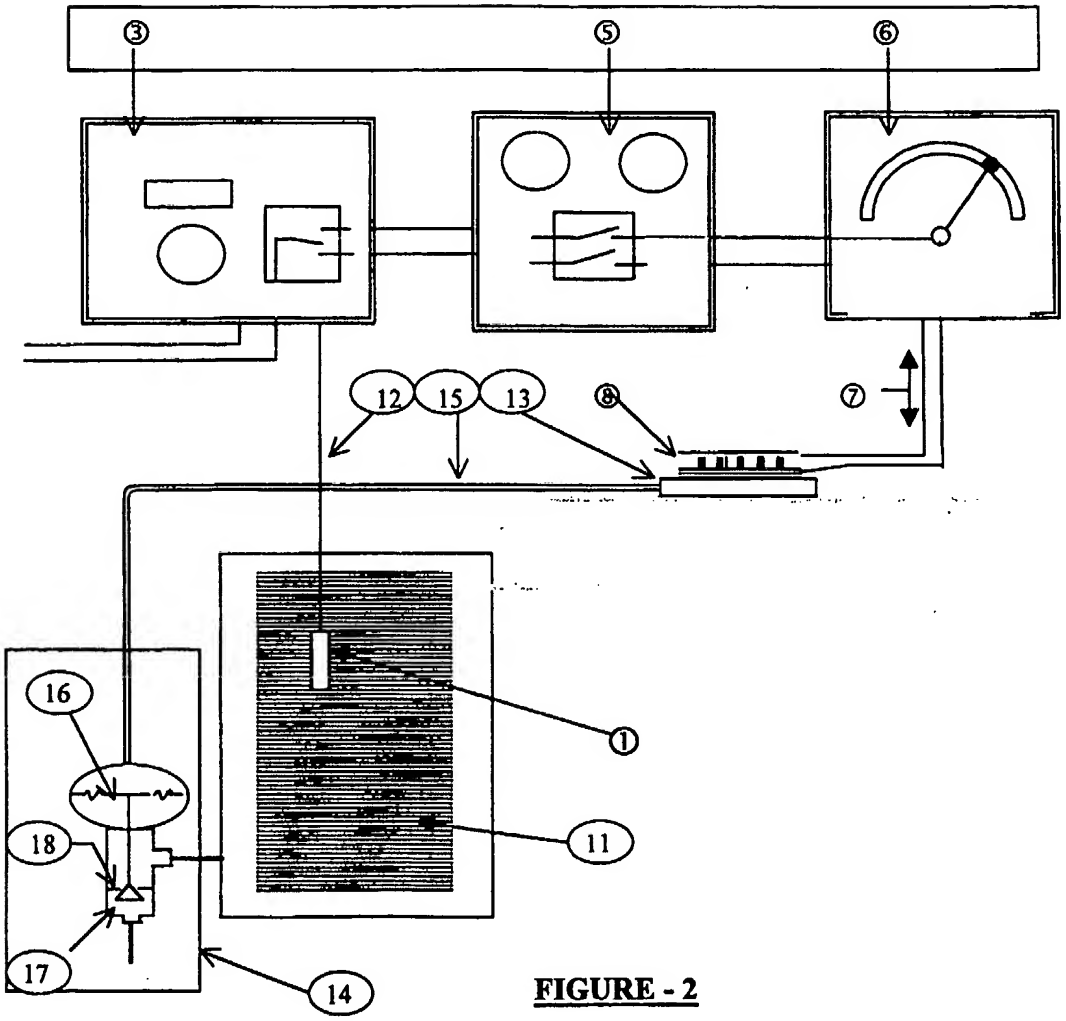

FIGURE - 2

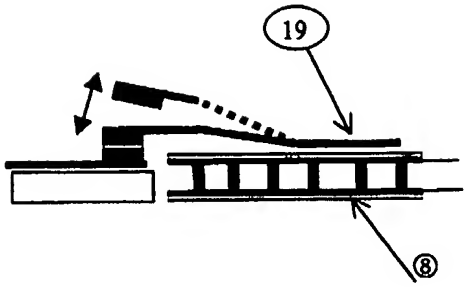

FIGURE - 3

INTERNATIONAL SEARCH REPORT

In tional Application No
PCT/IN 00/00027

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G05D23/19

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 G05D F03G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
PAJ, EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	PATENT ABSTRACTS OF JAPAN vol. 1999, no. 13, 30 November 1999 (1999-11-30) -& JP 11 223426 A (SHOWA ALUM CORP), 17 August 1999 (1999-08-17) the whole document	1
Y		1,2
Y	US 3 932 994 A (THOMPSON PAIGE W) 20 January 1976 (1976-01-20) abstract column 5, line 56 - line 93 column 8, line 29 - line 68; figure 2	1
Y	US 4 879 467 A (MULLER JEAN F ET AL) 7 November 1989 (1989-11-07) abstract column 2, line 11 - line 33	2

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
25 October 2000	07/11/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Helot, H

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INTERNATIONAL SEARCH REPORT

Information on patent family members

Ina tional Application No
PCT/IN 00/00027

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